Claims

[c1] A method of preparing a substrate for photolithographic patterning, comprising:
providing a substrate having at least an exposed rough surface layer including a polymeric material, said surface layer having surface features characterized by feature step height varying between about two percent and twenty percent of the minimum photolithographic half-pitch; and
depositing a layer of photoresist material over said surface layer.

[c2] A method as claimed in claim 1 wherein said layer of photoresist material is deposited onto said surface layer.

[c3] A method as claimed in claim 1 wherein said surface layer is formed by roughening an exposed surface of a polymeric material layer.

[c4] A method as claimed in claim 1 wherein said polymeric material layer is an anti-reflective coating (ARC).

[c5] A method as claimed in claim 1 wherein surface layer has a multiplicity of openings having a retrograde profile.

[c6] A method as claimed in claim 1 wherein said surface layer is roughened by sputter removal including at least one of ion milling and plasma sputtering of material from a layer of said polymeric material, said sputter removal being performed substantially without chemically etching said polymeric material.

[c7] A method as claimed in claim 6 wherein said sputter removal is performed by plasma sputtering using at least one gas selected from noble gases and bromine, hydrogen and nitrogen.

[c8] A method as claimed in claim 1 wherein said surface layer is formed by processing including simultaneously performing at least one of ion milling and plasma sputtering, while chemically etching a layer of said polymeric material.

[c9] A method as claimed in claim 8 wherein said processing is performed in an ambient including at least one gas selected from fluorides of carbon, sulfur fluoride, and noble gases.

[c10] A method as claimed in claim 1 wherein said surface layer is roughened by processing including simultaneously depositing and subjecting a second polymeric material layer to at least one of ion milling and plasma

sputtering, said second polymeric layer overlying a pre-existing first layer including a polymeric material.

[c11] A method as claimed in claim 10 wherein said processing is performed in an ambient including at least one gas selected from fluorides of carbon and flourides of hydrocarbons.

[c12] A method as claimed in claim 11 wherein said ambient further includes at least one noble gas.

[c13] A method as claimed in claim 1 further comprising photolithographically patterning said layer of photoresist material into photoresist patterns, at least some of which have photolithographic half-pitch of less than about 110 nm and a height-to-width aspect ratio of greater than about two and one half.

[c14] A method as claimed in claim 1, wherein said surface layer incorporates a multiplicity of nanoparticles providing roughness to said surface layer.

[c15] A method as claimed in claim 1, wherein said multiplicity of nanoparticles are incorporated while said surface layer is deposited.

[c16] A method as claimed in claim 14, wherein said multiplicity of nanoparticles are essentially inert.

[c17] A method as claimed in claim 16 wherein said multiplicity of nanoparticles are deposited onto a layer of said polymeric material to provide said surface layer.

[c18] A method of providing improved photolithographic patterning having reduced risk of pattern collapse, comprising:
providing a substrate having at least an exposed rough surface layer including a polymeric material having surface features characterized by feature step height varying between about two percent and twenty percent of 110 nm or less;
depositing a layer of photoresist material over said exposed rough surface layer;
photolithographically patterning said photoresist material layer into photoresist patterns, wherein at least some of said photoresist patterns have a photolithographic half-pitch of less than about 110 nm and a heightwidth aspect ratio of greater than about two and one half; and
etching a portion of said underlying layer exposed by said photoresist patterns.

[c19] A method of photolithographically patterning a layer of a substrate, comprising:
providing an exposed rough surface layer over an underlying layer of said substrate, said surface layer including

a polymeric material having features characterized by a step height varying between about two percent and twenty percent of the minimum photolithographic half-pitch;
depositing a layer of photoresist material over said exposed rough surface layer;
photolithographically patterning said photoresist material layer into photoresist patterns; and
etching a portion of said underlying layer exposed by said photoresist patterns.

[c20] A method as claimed in claim 19 wherein at least some of said photoresist patterns have photolithographic half-pitch of less than about 110 nm and a height-to-width aspect ratio greater than about two and one half.